

likely to confuse or excite the mind of the student ; on the contrary, the various contributors insert carefully chosen appropriate illustrations as the best means of elucidating the difficulties of the abstract theory. With us the spirit of the schoolmaster is too much abroad in our mathematical writings ; it has even been objected that these illustrations tend to obscure a subject, as it were, with the smoke of its own guns : a musty simile in these days of smokeless gunpowder.

Thus, for instance, the solution of a quintic equation is presented as required for the determination of the supply of a water-main (p. 13) ; very vulgar this, our college professor will say. So, too, the intuitive reasoning of a graphical procedure with an appropriate diagram has been freely employed to replace the tedious and unconvincing procession of formulas which impede the progress of our own students. A mention of M. Félix Lucas's electrical determination of the roots, real and imaginary, might well have found a place here.

Each of the eleven chapters of the book is undertaken by a different writer—Chapter i., on the Solution of Equations, by Mansfield Merriman ; and Chapter ii., on Determinants, by Laenas Gifford Weld ; both complete and original in their way.

The treatment, in Chapter iii., of Projective Geometry, by George Bruce Halsted, is very bright and stimulating ; this is a subject ignored in our own mathematical curriculum.

The two forms of spelling "centre" and "center," appear on the same page (95) ; the second is, of course, phonetically correct, as the English pronunciation always inverts the liquid and the vowel in the French spelling, here and in all similar words.

Chapter iv. is on Hyperbolic Functions, by James McMahon. Our scholastics look upon this subject as a temporary fad, which has not come to stay ; however, electricians find them indispensable, and many elegant electrical applications, among others equally important, of mechanical and astronomical interest, such as catenaries, loxodromes, charts, conjugate functions, will be found collected here.

The long form of these functions, cosh, sinh, tanh, . . . has been retained, with a suggestion that the ugly sounds they suggest should be avoided by pronouncing them *h*-cosine, *h*-sine, *h*-tangent, &c. But the modern continental practice is to abbreviate the symbols to ch, sh, th, pronouncing only the letters *c-h*, *s-h*, *t-h*, as with the Elliptic Functions ; so also for their inverse functions, ch^{-1} , sh^{-1} , th^{-1} , employed here, for their obvious advantages in integration. A well-arranged table concludes this chapter ; we miss, however, Bernoulli's numbers in their proper place in the expression of $\tan x$, th^{-1} , . . .

Prof. Byerley, of Harvard, contributes Chapter v., on Harmonic Functions. When his genial treatise on Fourier's Series and Harmonic Analysis made its appearance, some four years ago, it was welcomed by all physicists as the long-desired manual, which placed this subject before them in an intelligible manner, devoid of artificial obstacles and impediments. Unfortunately the treatise fell into the hands of mathematical critics, who could see little merit in the book, because it passed over in silence the tedious, and useless, arguments concerning the legitimacy of the expansions. If an electrician is to

employ a Fourier Series, he will content himself with the first two or three terms of the series ; just as the calculator of mathematical tables will not, for practical purposes, employ more than three, or four terms at most, in Taylor's Series. But where the applicability becomes doubtful, by reason of the neighbourhood of a discontinuity, he will assure himself, by a diagram such as those on p. 199, of the limits of the divergence.

These difficulties concerning the discontinuity of functions is very properly relegated to another chapter, number vii., on Functions of Complex Variables, by Thomas S. Fiske, which gives us a very clear account of the most recent manner, of the school of Weierstrass, of approaching such refinements of argument. We are pleased to find the name "one-valued function" instead of "uniform function," which is misleading to the beginner.

Prof. Woolsey Johnson, of the U.S. Naval Academy, contributes Chapter vii., on Differential Equations. His own formal treatise on the subject is well known and highly popular ; and the present chapter incorporates the essential, or what Maxwell called the "gentlemanly," knowledge of the subject.

The next two chapters—Chapter viii., on Grassmann's Space Analysis, by Edward W. Hyde, and Chapter ix., on Vector Analysis and Quaternions, by Alexander Macfarlane—seem to us by comparison to be of the nature of luxuries, appealing to the purely analytical spirit ; although even here electrical applications are introduced to show how the theories may be usefully applied.

Chapter x. is a short and useful *résumé*, by R. S. Woodward, of the principal parts of Probability and the Method of Least Squares, with which every physical student should now be familiar ; and the volume concludes with Chapter xi., on the History of Modern Mathematics, by David Eugene Smith, in which the author is compelled to apologise for the incompleteness imposed upon him by the exigencies of room, but which, nevertheless, provides the most important details required for reference.

The account given by the Editors, in the preface, of the work expected of the average American student, shows that the standard of requirement is much higher than in this country, and not hampered by traditional prejudice.

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OSTEOLOGY.

The Vertebrate Skeleton. By Sidney H. Reynolds, M.A. Pp. xvi + 559. (Cambridge : University Press, 1897.)

THIS most recent addition to the Biological Series of the Cambridge Natural Science Manuals edited by Mr. A. E. Shipley, is an attractive-looking volume, well printed, and with the monotony of the text agreeably broken by a judicious use of small capitals, italics, and clarendon type. The numerous illustrations, which are probably accountable for the high price (12s. 6d.) of the book, though simple in execution are clear in detail, and, on the whole, chosen with discretion. The majority of the figures have not been published before, and are based on specimens contained in the Cambridge University Museum and the Natural History Museum, London. The text is remarkably free from typographical errors, but is frequently bald in style and irritating from

unnecessary iteration. This repetition, it is true, is apologised for in the preface, but it could have been avoided by altering the plan of the book, which as it stands is rather confusing.

What strikes one most on glancing through the pages is the disproportionate treatment of the subject. To devote one-third of the whole book to the mammalian skeleton shows that the author has allowed himself a free hand where the facilities for compilation are greatest—and his indebtedness to the "Osteology of the Mammalia" is admitted in the preface. Where, however, it has been necessary to collect the detailed statements from scattered sources, as, for instance, in Fishes and Amphibia, the results are very far from satisfactory. The parts relating to the Cyclostomi, Ganoid fishes, the shoulder-girdle of Anura, and the hyoid of Reptilia are especially poor. The classificatory scheme (pp. 30-49), including as it does extinct as well as living vertebrates, should prove of considerable service to the student. It is well up to date, and, on the whole, trustworthy, although ichthyologists will probably gird at the inclusion of a physoclistous form like *Exocoetus* among the Clupeidae. It would have been well if the generic and specific names of the borrowed figures had been checked by reference to some modern catalogue, instead of relying so implicitly upon those used by the original authors. *Galeus*, for instance (Fig. 15), should read *Galeocerdo*, and *Docidophryne gigantea* (Fig. 30), *Bufo marinus*; while the Figs. 16 and 17 of the seven-gilled shark should, in the student's interests, be given the same generic name, either *Notidanus* or *Heptanchus*. The specimen in the Natural History Museum, on which Fig. 16 is based, is marked *Notidanus*, while Gegenbaur's figure, which is reproduced in Fig. 17, is labelled *Heptanchus*, and Mr. Reynolds has, regardless of uniformity, adopted the two names as he found them.

The want of cohesion throughout the text detracts seriously from the value of the book. The various sections, culled from different sources, are not blended together, so that the product is indigestible and difficult of assimilation. The failure to treat the subject from a consistent morphological point of view is, in fact, the great flaw in the book. Positive inaccuracies are not common, but the sternum ought not to come under the head "Hyoid apparatus" (p. 162), the epipubic cartilage of *Xenopus* (p. 188) and the horny beaks of *Siren* (p. 168) are not "minute," and auditory ossicles are not as large as Fig. 100 would lead one to believe. The application of the name "branchiostegal rays" to the endoskeletal cartilages of the branchial septum of selachians (p. 120) implies a false homology with the dermal bones attached to the hyoid arch in bony fishes, while the inclusion of the vomer of the dog (p. 395), under the head "Bones in relation to the Olfactory Capsules," fails to impress upon the student the fact that this bone is morphologically an ossification of the mucous membrane of the roof of the mouth.

That great credit is due to Mr. Reynolds for his conscientious industry and honesty of purpose there is abundant internal evidence to show, but the product of his labours is—a book which is just good enough to suggest how valuable it might have been had its compilation been entrusted to a qualified morphologist. At the same time, Mr. Reynolds is to be congratulated on

the large amount of information which he has brought together, and on the fact that he has not neglected the extinct forms. And although, in its present form, the book cannot with advantage be used as a book of reference, while its abrupt and disconnected style renders it ill-adapted for continuous reading, there can be little doubt that if, when a second edition is called for, the plan of the book were simplified, the inaccuracies corrected, and the various chapters and sections connected up and coordinated, the book would prove a valuable addition to the student's library.

OUR BOOK SHELF.

Studien über Dampfspannkraftmessungen. By Georg W. A. Kahlbaum; with the co-operation of C. G. von Wirkner and others. Part ii. 1st half. Pp. x + 221. (Basel: Benno Schwabe, 1897.)

IN the first part of this work (NATURE, March 8, 1894, p. 436), measurements of the vapour pressures of a number of substances were given. The method used in the determinations was also fully described, and its accuracy discussed. The author's intention was to devote the second part of the book to a discussion of the theoretical bearing of the experimental material collected. Further experiments with substances belonging to chemical groups other than those previously examined revealed, however, the necessity of first enlarging this experimental material; the present volume contains the results of these additional measurements. The experimental method employed is the same as before, and the results are given in the form of numerical tables and of curves. Every precaution appears to have been taken to secure accuracy. Where previous observations exist, the results are compared together, and the satisfactory agreement found between the results obtained by Ramsay and Young, for example, by the statical, and by the authors by the dynamical method, may be regarded as further evidence of the trustworthiness of the latter. In this volume the measurements extend from about 0 to 760 mm., except in cases where the solidification of the substance prevented the measurements at lower pressures. The substances for which new experimental results are given are benzene, brom-benzene, benzaldehyde, phenol, aniline, benzonitrile, benzyl alcohol, nitrobenzene, benzoic acid, ethyl alcohol, propionic, normal butyric, valeric, heptylic, isobutyric and isocaproic acids, methyl-, dimethyl-, ethyl- and diethyl-aniline, phenyl-methyl ketone, methyl benzoate and benzoyl chloride.

In connection with the fatty acids, the accuracy of Dühring's rule is discussed. The rule states that the difference between the boiling-points of a liquid at some standard pressure and at any other pressure divided by the corresponding difference for some other liquid is a constant quantity for that pair of liquids. This, it appears, is sufficiently accurate only when the liquids belong to a group of closely related substances, such as the fatty acids.

In conclusion, it is hardly necessary to point out the great value, scientific and practical, of careful determinations, such as those before us, of the vapour pressures of liquids.

The Induction Coil in Practical Work, including Röntgen Rays. By Lewis Wright. Pp. vi + 172. (London: Macmillan and Co., Ltd., 1897.)

THE discovery of the Röntgen rays has created a revived interest in many of the beautiful experiments that can be performed with the aid of the Ruhmkorff induction coil, and is thus indirectly a sufficient justification for the appearance of this treatise of 172 pages. More especially